STATUS OF INTRODUCED FISHES IN CERTAIN SPRING SYSTEMS IN SOUTHERN NEVADA

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Abstract.— We record eight species of exotic fishes as established, reproducing populations in certain springs in Clark, Lincoln, and Nye counties, Nevada. These include an unidentified species of *Hypostomus*, *Cyprinus carpio*, *Poecilia mexicana*, *Poecilia reticulata*, a *Xiphophorus* hybrid, and *Cichlasoma nigrofasciatum*. *Tilapia mariae*, established in a spring near the Overton Arm of Lake Mead, and *Tilapia zilli*, established in a golf course pond in Pahrump Valley, are recorded for the first time from Nevada waters. Though populations of transplanted *Gambusia affinis* persist, other populations of *Poecilia latipinna* are apparently no longer extant. *Cichlasoma severum*, *Notemigonus crysoleucas*, *Poecilia latipinna*, and *Carassius auratus* were apparently eradicated from Rogers Spring in 1963.

Miller and Alcorn (1943), Miller (1961), La Rivers (1962), Deacon et al. (1964), Hubbs and Deacon (1964), Minckley and Deacon (1968), Minckley (1973), Hubbs et al. (1974), Deacon (1979), Hardy (1980), and others recorded the presence of non-native fishes in Nevada. In those papers, it was stressed that the introduction of nonnative fishes, be they exotic (of foreign origin) or transplants native to other areas of the United States, can have serious, adverse impacts on the depauperate and often highly endemic fish fauna in the southwestern U.S. Deacon et al. (1964) emphasized that most of the endemic fishes are small and, therefore, subject to more adverse impacts through introductions of small bait or ornamental fishes than with earlier introductions of larger fishes, a subject reviewed by Hubbs and Broderick (1963).

In this paper, we document eight species of exotic fishes in three counties of southern Nevada. One of these fishes, the spotted tilapia (*Tilapia mariae*), was previously known to have become established only in Florida (Hogg 1974, 1976, Courtenay and Robins 1975, Courtenay 1979b, 1980, Courtenay and Hensley 1979, 1980). Another, the redbelly tilapia (*Tilapia zilli*), has been recorded as established in Arizona, California, and Texas (Courtenay and Hensley 1980). Our purpose is to update the status of introduced fishes in southern Nevada, primarily from the reports of Deacon et al. (1964) and Hubbs and Deacon (1964).

Clark County

Indian Spring is 2 km south of U.S. Highway 95, approximately 62 km northwest of Las Vegas in the village of Indian Springs. Minckley (1973) recorded a suckermouth catfish (*Hypostomus*) as successfully established since at least 1966 "in a warm spring in southern Nevada"; this reference was to Indian Spring. Brief examination of Indian Spring by Deacon since 1966 demonstrates that the population has remained common and continues to reproduce successfully. The deeply undercut banks with numerous tree roots and holes provide excellent refuge for this rather cryptic species. Our collection on 18 October 1980 yielded only one specimen, despite repeated seining. A local resident advised us that local youngsters had removed as many as 500 individuals in recent months, probably for sale to pet shops in Las Vegas; this, predation on eggs by an introduced snail (*Melanoides tuberculata*), competition from other introduced fishes, or a combination of these factors could explain the apparent population decline of *Hypostomus* he felt had occurred. On 25 June 1981 a reexamination of the spring pond using a face mask and a light to observe the undercut banks demonstrated

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that *Hypostomus* continues to exist in relatively high density in Indian Spring. Individuals of all sizes were seen hiding in or around almost every available hole, tree root, or rock.

Suckermouth catfish have been recorded as established in Texas (Barron 1964, Hubbs et al. 1978) and Florida (Courtenay and Robins 1973, Courtenay 1979b, 1980). The specimen collected at Indian Spring is morphologically distinct from those collected in Texas and Florida and represents a third species of *Hypostomus* established in the U.S.

Deacon (pers. comm. to D. A. Hensley) also recorded the green swordtail (*Xiphophorus helleri*) from Indian Spring in 1975. Although we found no green swordtails at Indian Spring on 18 October 1980, a yellow to pale orange hybrid swordtail (probably *X. helleri* x *X. maculatus*) was found to be the dominant fish in number of individuals. Guppies (*Poecilia reticulata*) were also abundant and several large common carp (*Cyprinus carpio*) were seen but not collected. The only other species present was the mosquitofish (*Gambusia affinis*).

Blue Point Spring is in the Lake Mead National Recreational Area above the Overton Arm of Lake Mead, approximately 68 km northeast of Las Vegas. Deacon et al. (1964) recorded guppies, shortfin mollies (*Poecilia mexicana*), and the southern platyfish (*Xiphophorus maculatus*) from Blue Point Spring. In a collection made 18 October 1980, no guppies or southern platyfish were found; however, shortfin mollies, convict cichlids, and a single spotted tilapia with damaged pelvic fins were captured. Deacon et al. (1964) also reported a transplant, the sailfin molly (*Poecilia latipinna*), from Blue Point Spring; we did not collect this species there and it is assumed that the population died out.

Rogers Spring is located 2 km southwest of Blue Point Spring in the Lake Mead National Recreational Area. Deacon et al. (1964) reported convict cichlids, goldfish (*Carassius auratus*) and transplanted sailfin mollies, golden shiners (*Notemigonus crysoleucas*), and mosquitofish from Rogers Spring. Hubbs and Deacon (1964) reported convict cichlids, shortfin mollies, transplanted sailfin mollies, and the banded cichlid (*Cichlasoma severum*) from this spring. An attempt to remove the introduced fishes was made in December 1963. We seined Rogers Spring on 18 October 1980. The dominant fish (in numbers and biomass) was the spotted tilapia (*Tilapia mariae*). Shortfin mollies were very abundant, convict cichlids were rare, and two guppies were collected. Underwater observations made prior to the seine hauls correlated well with the population densities revealed by seining. No banded cichlids, sailfin mollies, golden shiners, or mosquitofish were seen or collected, and they are considered as no longer extant in Rogers Spring.

Of particular interest were the underwater observations on spotted tilapia prior to seining activities. Most of the tilapias, even large individuals (above 100 mm SL), displayed the banded juvenile pattern as illustrated by Thys van den Audenaerde (1966). Only a relatively few large individuals showed the typical adult pattern of spots on their sides (Fig. 1). Moreover, it was later noted, following seining, that most of the tilapias displaying the juvenile color pattern were missing parts or most of their pelvic fins (Fig. 2) and that other fins (particularly the soft dorsal and upper half of the caudal) often showed damage. The only fish in Rogers Spring capable of inflicting such damage were the adults with the typical adult color pattern; none of those had damaged fins.

At no time have population densities of *Tilapia mariae* in Florida been observed to be approaching those seen in Rogers Spring. It is probable that the trophic and spatial carrying capacities of Rogers Spring for spotted tilapia have been reached and that this behavioral hierarchy, led by a few highly aggressive individuals, has developed to control further overpopulation.

LINCOLN COUNTY

Deacon et al. (1964) did not find any exotic fishes at either Crystal Spring or Ash Springs in the Pahranagat Valley, some 145 km north-northwest of Rogers Spring during collecting trips on 2 February and 9 March 1963. They did find an introduced population of mosquitofish at Ash Springs that was reported earlier by Miller and Hubbs (1960). During a collecting trip on 3 June 1964,

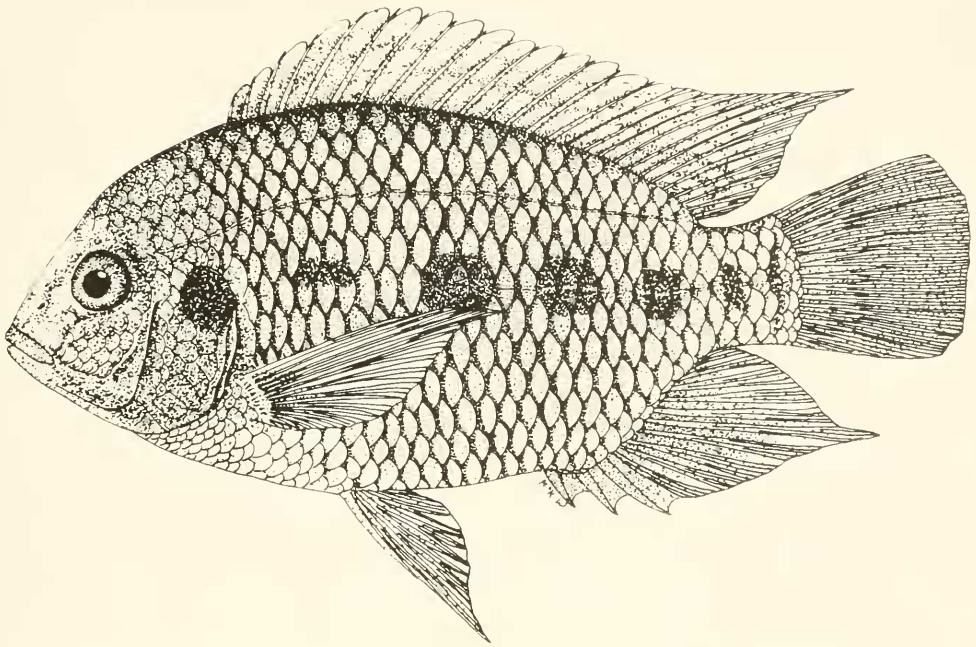

Fig. 1. An adult spotted tilapia, 205 mm standard length. Drawing by Francis McKittrick Watkins.

convict cichlids, shortfin mollies, and transplanted sailfin mollies were discovered in Ash Springs (Hubbs and Deacon 1964). The probable source of these introduced fishes was suggested as Rogers Spring because all three species were known to exist there. The same three non-native fishes subsequently spread from Ash Springs to Crystal Spring, 8 km to the north-northwest.

On 17 October 1980, surface and underwater observations, as well as seine collections, made in the outflow of Ash Springs showed convict cichlids to be dominant in biomass, followed by shortfin mollies that were dominant in numbers of individuals. Transplanted mosquitofish were common and no sailfin mollies were seen or collected. Introduced fishes were somewhat uncommon in a pool occupied by 35–40 individuals of the Pahranagat roundtail chub (*Gila robusta jordani*).

NYE COUNTY

Goldfish, *Carassius auratus*, were reported by Deacon et al. (1964) and by Deacon (1979) in Pahrump Valley at Manse Ranch Spring. Manse Ranch Spring dried up for a short time in the summer of 1975 (Soltz and Naiman 1978), thus eliminating the goldfish. About 10 km to the north of Manse Ranch Spring is the site of Pahrump Spring, originally the largest spring in Pahrump Valley. Pahrump Spring failed in the late 1950s because of excess pumping of groundwater for irrigation. During the late 1970s the surrounding area was subjected to a land development plan that included construction of a golf course and park area. The ponds and small stream associated with this development use groundwater from the vicinity of the former spring source. Examination of the main pond in Cottonwood Park by the Nevada Department of Wildlife on 4 March 1980 and by one of us (Deacon) on 16 July 1981 revealed the presence of large numbers of goldfish and mosquitofish and relatively small numbers of the redbelly tilapia, *Tilapia zilli*. The specimens of redbelly tilapia collected were all small, but one pair of larger fish (to ca 250 mm) was seen in the water in July, apparently guarding nests or young. The manager reported that large numbers of *Tilapia* died last winter when the water temperature reached 58 F (14 C). This species has maintained itself through at least two

Fig. 2. A spotted tilapia, 73.5 mm SL, from Blue Point Spring. Note damaged pelvic fins.

winters and has reproduced during the summers of 1980 and 1981. A small population is able to exist through the winter apparently because the inflowing water maintains a temperature of about 70 F (21 C).

DISCUSSION

Courtenay et al. (1974) termed the promiscuous introduction of exotic fishes to new environments as biological pollution. Unlike chemical or thermal pollutants, biological additives have the ability to reproduce and expand their ranges. Moreover, many exotic fishes may appear to be trophic specialists in their native range but prove to be passive generalists (Birkeland and Neudecker 1981) in new environments where most or all of the biological constraints of the native range are absent (Courtenay and Hensley 1980). Such trophic adaptation, coupled frequently with equally adaptable behavioral traits, permits the exotic species to disrupt habitats and niches (*sensu lato*) in new environments.

The introduction of any non-native fish will result in alterations in the host ecosystem. Such alterations may range from minor, almost unnoticeable changes in native fish populations to the extinction of one or more native species (Courtenay 1979a, Courtenay and Hensley 1980). In Florida, for example, comparatively small ornamental fishes, cichlids in particular, are able to successfully invade and become dominant in waters that contain larger native piscivores such as largemouth bass (*Micropterus salmoides*) and Florida gar (*Lepisosteus platyrhincus*). Invasion and domination by nonnative fishes in many parts of the desert southwest is facilitated by the absence of piscivores and the presence of small endemic fishes that have had no previous experience with trophic passive generalists or piscivores. Therefore, a fish that feeds on phytoplankton or detritus in its

native range and either becomes a predator of smaller fishes or feeds on algae in the new environment is a clear threat to many native fishes in the southwestern U.S.

It is obvious that there have been several changes in the introduced fish fauna in southern Nevada since 1963. Species compositions have changed. The green swordtail population in Indian Spring is gone and has been replaced with a hybrid of *Xiphophorus*; a population of a suckermouth catfish remains extant there. Guppies, southern platyfish, and sailfin mollies appear to be absent in Blue Point Spring, and at least one spotted tilapia was released, probably recently, before our collections there. Sailfin mollies, mosquitofish, and the banded cichlid are absent in Rogers Spring, the latter probably due to the eradication effort in 1963; convict cichlids are now rare, but guppies and spotted tilapia (the latter now dominant) have been added. Sailfin mollies appear to be absent from the outflow of Ash Springs in the Pahranagat Valley, whereas convict cichlids and shortfin mollies are dominant, 17 years after their introduction.

Frequent and closer monitoring of introduced fish populations, particularly in areas that are potential or recognized release sites for unwanted pet fishes in southern Nevada and other areas in the desert southwest, is needed. These "pockets" of introduced fishes serve as potential and probable sources for future introductions elsewhere as apparently occurred with the transfer of convict cichlids and shortfin mollies from Rogers Spring to Ash Springs in 1963. A further indication of the constant or continuing nature of this problem is a verbal report from Mr. Charles Orr, a Las Vegas member of the American Cichlid Association, that he saw and identified several specimens of the "marmalade" form of *Pseudotropheus zebra* when he visited Rogers Spring in July 1981.

Although the disappearance of some introduced fishes in southern Nevada in recent years may be of some interest, it is far more important that studies be initiated to define the impacts of introduced species on native fishes. Species interactions between nonnative and native fishes have been suggested as reasons for declines in populations of native fishes (Deacon et al. 1964, Hubbs and Deacon 1964, Courtenay and Hensley 1980), but to date the exact mechanisms for these declines have not been examined. The "cause and effect" for such declines is suggested strongly but requires in situ observations and evaluations.

Finding an established population of spotted tilapia in southern Nevada is particularly disturbing. Although this fish is omnivorous, it shows a preference for green algae in Florida and in its native range has been described as "une forme intermédiaire entre les *Tilapia* herbivores et les espèces microphages" (Thys van den Audenaerde 1966). The bottom of Rogers Spring was devoid of green algae, doubtlessly due to grazing by spotted tilapia. A trophic preference of this type, coupled with omnivory, could prove disastrous to several endemic species and subspecies of southwestern fishes if this western African cichlid were moved elsewhere. We therefore recommend its immediate eradication. Much the same result could be expected by future introductions of other tilapias (*sensu lato*) or such seemingly harmless fishes as *Hypostomus* spp. Also, the potential introduction of fish parasites via exotic fish vectors exists (Lachner et al. 1970, Courtenay and Robins 1975, Courtenay 1979a) and has been suggested to have occurred in southern Nevada (Deacon 1979) and elsewhere (Hoffman 1970, Bauer and Hoffman 1976).

Fish introductions pose as great a threat to the continued existence of the depauperate fish fauna in southern Nevada and adjoining states as does water withdrawal for agricultural, domestic, military, and industrial uses or other habitat modifications.

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